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Sonargaon University (SU)
সোনারগাঁও ইউনিভার্সিটি (এসইউ)

DESIGN & FABRICATION OF MULTIPURPOSE AGRICULTURAL ROBOT USING SMART PHONE CONTROL SYSTEM

A thesis
by

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DEPARTMENT OF MECHANICAL ENGINEERING
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SEPTEMBER 2025

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ABSTRACT

The Agricultural Robot project aims to develop a mechanically driven robot to assist in basic farming tasks, focusing on efficiency, time-saving, and labor reduction. This robot relying on a pre-designed mechanical system and motorized movement to navigate farmland and perform agricultural activities such as planting, watering, and soil tilling. It uses a simple motor-driven wheel system combined with gears, pulleys, and programmable movement paths to ensure coverage of the field in a structured and consistent manner. The robot's design emphasizes reliability, low maintenance, and cost-effectiveness, making it suitable for small to medium-scale farms. By automating repetitive tasks, it minimizes human effort while maintaining productivity and uniformity in crop care. The project demonstrates a practical approach to mechanized agriculture, showing how mechanical and electrical integration can improve farm operations without relying on complex electronics or sensors. This robot represents an accessible solution for farmers seeking to modernize their practices, increase efficiency, and reduce manual labor through simple, robust automation.

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CHAPTER - 1

INTRODUCTION

1.1 Overview

Agriculture is the cultivation of animals, plants, and fungi used to sustain and enhance human life agriculture was the key development in the rise of sedentary human civilization. Agriculture has been around for thousands of years, and its evolution has been shaped by vastly different climates, cultures, and technologies. Modern agronomy, plant breeding, agrochemicals such as pesticides and fertilisers, and technological advances have in many cases dramatically increased crop yields while causing widespread ecological damage. Agricultural food production and water conservation are becoming increasingly global concerns. Mechanized agriculture is the method of using agricultural machinery to mechanise agricultural work, significantly increasing farm worker productivity in modern times, and powered machinery has replaced many farm jobs previously performed by manual labour or by working animals like oxen, goats, and mules Many examples of the use of implements, such as the hoe and plough, can be found in agricultural history. However, the continuing integration of machinery since the industrial revolution has enabled farming to become much less labour intensive. Today's mechanised agriculture entails the use of tractors, trucks, combine harvesters, and a plethora of farm implements, airplanes and helicopters, and other vehicles. Mechanization was a major contributor to rapid urbanization and the development of modern economies. Mechanization, in increase production productivity, allows large-scale production and, in some cases, can enhance the quality of farm produce; however, it can displace unskilled farm labour and affect environmental destruction, especially if used in a short-sighted rather than holistic manner.

Agriculture is the backbone of Bangladesh. The history of agriculture in Bangladesh dates back to ancient times, with rice cultivation being a central part of the country’s economy and culture for centuries. Today, Bangladesh is among the leading countries in farm production in South Asia. Special vehicles and mechanized systems play a major role in various fields such as industrial, medical, and military applications, and their use in

agriculture is gradually increasing productivity. Some of the major problems in Bangladeshi agriculture include rising input costs, shortage of skilled labor, limited water resources, and challenges in crop monitoring. To address these issues, automation and mechanization technologies are being adopted in agriculture, helping farmers improve efficiency, reduce labor dependency, and optimize resource use.The agricultural census gives vital information on the distribution of land holdings in our country. According to the census majority of the farmers are having the land less than 1 hectare . This is one of the major drawbacks for the mechanization in agricultural sector in India. The vehicles are being developed for the processes for ploughing, seed sowing, leveling, water spraying. All of these functions have not yet performed using a single vehicle. In this the robots are developed to concentrate in an efficient manner and also it is expected to perform the operations autonomously. The proposed idea implements the vehicle to perform the functions such as ploughing, seed sowing, mud leveling, water spraying.

1.2 Problem Statement

Traditional agricultural practices are labor-intensive, time-consuming, and often inefficient, especially for small and medium-scale farmers who lack access to advanced machinery. Manual farming methods lead to inconsistent results, increased physical strain, and higher operational costs. Additionally, the shortage of skilled labor and rising demand for food production present significant challenges. There is a pressing need for a cost-effective, automated solution that can perform multiple farming tasks with precision and minimal human intervention. The development of a multipurpose agriculture robot addresses these issues by integrating various functions—such as sowing, spraying, and monitoring—into a single, efficient, and sustainable robotic platform.

1.3 Objective

The objectives of this project are:

- To design and construct a Multipurpose Agriculture Robot.
- This project objective is to fabricate a robot vehicle put the seeds, and close the mud and to spray water,
- To farmer can operate this robot through remote by sitting at one side and he can operate easily.
- To save human energy and water consumption

1.4 Methodology

Our methodologies for the project:

- Creating an idea for design and construction of an Multipurpose Agriculture Robot. And designing a block diagram & circuit diagram to know which components we need to construct it.
- Collecting all the components and programming the micro controller to control the whole system.
- Setting up all the components in a PCB board & then soldering. Lastly, assembling all the blocks in a board and to run the system & for checking purposes.

1.5 Work Flow Diagram

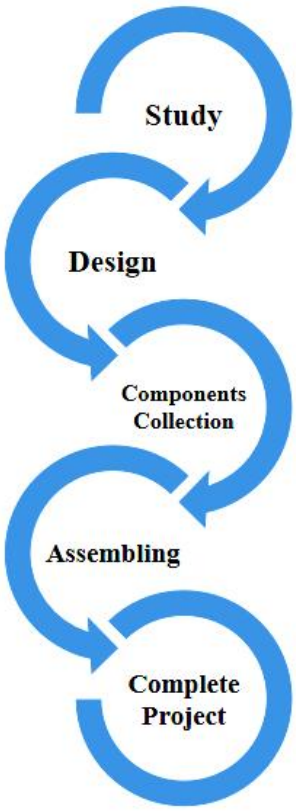


Figure 1.1: Working Flow Diagram

1.6 Research Outline

This project book consists of Six chapter. The first chapter contains the statement of the introduction,Overview, Problem Statement, Work Flow Diagram, objectives of the study and Methodology. Chapter two contains system Literatur e Review details. Chapter three Discussed in Block Diagram,Circuit Diagram,Working principle and Cost analysis.Chapter Four describes the hardware implementation with component details and the software which we have used for our work. Chapter Five deals with the result Analysis,shows the complete prototype,Advantage, Application and Limitation of the project that we have built. In the final chapter, we have discussed the , Future Scope, conclusion of the project.

CHAPTER - 2

LITERATURE REVIEW

2.1 Introduction

In this chapter we discuss our system overview. In this paper they also work about **Multipurpose Agriculture Robot**. In below section we will describe some previous literature review. From previous literature we gather more knowledge to build this project and we successfully made it .

2.2 Literature Review

Firas B. Ismail et.al [1]: This research has the conventional grass cutters have been widely used recently by workers in the gardening and agricultural industries. However, the manual handled grass cutters are consuming a lot of energy and producing air pollution which can directly affect the workers' health. The conventional grass cutters are also creating a high level of noise and vibration which can cause serious health issues such as grip strength, decreased hand sensation and dexterity, finger blanching or 'white fingers' and carpal tunnel [1].In order to address these issues, a new design of a grass cutter machine has been proposed. This device can be fueled by solar energy and smartly controlled, which has been named as a Smart Solar Grass Cutter that has three main systems which are smart control system, solar system, and the grass cutter. According to the national air space association (NASA), there is a 1.361 kW/m² of solar irradiance received at the top of Earth's atmosphere

T. Koppel et.al [2]: The aim of this study was to compare vibration and noise characteristics caused by different types of lawn maintenance machines in association with the risk factors to workers' health. In the present study, the method connecting vibration hazard, health damages and risk levels is presented. Three types of agriculture machines were investigated: all-terrain vehicles (ATV), simple lawn-mowers, ride-on mowers. These machines are used not only in occupational settings, but also by the inhabitants for cutting grass. The gardeners and maintenance workers of the municipal authorities use

them daily, sometimes 8 hours a day. The protective equipment against noise is used in occupational settings, but hardly by the public. Noise was evaluated using a Sound Level Meter (TES 1358) following the standard ISO 9612:2009. Vibration was determined as acceleration, velocity and amplitude – measured using a Vibration Dosimeter & Analyser (SV 100) following the standards ISO 2631-4, EVS-EN 5349-2. The risk to the health is assessed by the original flexible risk assessment method worked out in TTU. On the basis of this flexible model the scheme for connecting the local and whole-body vibration hazards and possible health damages was worked out. The results showed that there are differences in the noise and vibration generated by the ATV, lawn-mowers and ride-on mowers. The safest was ride-on mower (local vibration below 1.15 m (s2) -1). Lawnmowers gave high vibration levels (over 3 m (s2) -1). The personal protective equipment (PPE) has to be worn by all users of the investigated machines. The noise spectral content by these three types of machines is presented and it is different. This enables to choose the right type of ear-muffs by the frequency of noise. The PPE against vibration is also available.

R. V. Sanjana Arunesh et.al [3]: Grass cutter machines have become very popular today. Most common machines are used for soft grass furnishing. This project aim at developing the Grass cutter operation and construction. The main parts of the Grass cutting machines are DC motor of 75HP capacity, relay switch for controlling motor, Battery for charging it through solar panel. It is placed in a suitable machine structure. The motor have 18000 rpm and it is connected to the electric supply by the use of a roll of wire. The motor rpm increased by the help of gears. Motor controlled by an electric switch for easy operation. The tempered blades are attached in this machine. The raw materials mainly used are GI sheet, motor, switch, wheel, wire, aluminum sheet, square pipe, paint, insulating material and other standard item like nuts, bolts and reverts. The machines required for manufacturing includes welding machine, grinding machine etc. Working principle of the grass cutter is providing a high speed rotation to the blade, which helps to cut the grass. The blade will get kinetic energy while increasing the rpm. The cutting edges are very smooth and accurate. Also Electric Grass Cutting Machines are much easier to be used in garden, lawn and grass fields. In order to enhance the beauty of home- lawns and gardens, Grass cutting machines are the best available option in the industry. With the help of a lawn mower which is a machine with revolving blades to help us cutting lawns at even

length, people can easily maintain and beautify their lawns and gardens without any hassle. Now-a-days, there are plenty of options starting from the simplest push along mower to the most advanced electric grass cutting machine. According to world energy report, we get around 80% of our energy from conventional fossil fuels like oil (36%), natural gas (21%) and coal (23%). It is well known that the time is not so far when all these sources will be completely exhausted. So, alternative sources should be used to avoid energy crisis in the nearby future.

Aybek, A., Kamer et.al [4]: Approximately one million agricultural tractors are used in Turkey for crop production and about onethird of the population lives in rural areas. The objectives of this study were to determine sound pressure levels, A-weighted sound pressure levels, and the permissible exposure time for tractors without cabins, field-installed cabins, and original cabins at ear level of agricultural tractor operators for following machines: plows, cultivators, top soil cultivators, rotary tillers, tool combinations (harrow þ roller), mechanical drills, pneumatic drills, chemical applicators, fertilizer applicators, drum mowers, balers, and forage harvesters. Variance analyses showed that type of operation, type of cabins, and operation cabin interactions were statistically significant ($P < 0.01$) both for sound pressure levels and equivalent (A-weighted) sound pressure levels. The use of original cabins had a greater effect in decreasing average sound pressures and resulted in more efficient noise insulation, especially at higher center frequencies compared to field installed cabins whereas field-installed cabins proved to be more favorable compared to tractors without cabins. Sound pressure levels at 4000 Hz center frequency was reduced 2–13 dB and 4–18 dB by using a field-installed cabin and an original cabin, respectively. The measured A-weighted equivalent sound pressure levels were compared to the threshold limit level, and was concluded that depending on the cabin types used, the operators could usually work from 4 to 6 h a day without suffering from noise induced inconveniences while 2–3 h is permissible for plowing and forage harvesting on tractors without cabins. Due to timeliness considerations in agricultural machine operations, a farmer would not be willing to interrupt the operation based on permissible exposure time set by the standards.

B. P. Dilip et.al [5]: Nowadays, pollution is the major issue in the universe. In case Gas powered lawn mowers due to the emission of gases it is responsible for pollution. Also the

cost of fuel is increasing hence it is not efficient. Traditionally, lawn mowers are often clunky pieces of machinery that involves a lot of strength and energy to use. These present and hightech grass cutters however, have been creatively designed to make the whole landscaping process much simpler and easier for the user. From robotic lawn mowers that can incredibly cut the grass for you to those that are cleverly powered by solar energy, these convenient and easy-to-use grass-cutting devices make straightening up your lawn more pleasing. The Grass Cutters use cordless electric mowers, trimmers and blowers powered by clean renewable energy generated by solar panels mounted on our trucks and trailers. We also use reel push mowers for smaller hard to access areas like pathways and parks. There's no oil, and no pollution. Just clean air, less noise, and green grass.

F. D. W. Praful et.al [6]: This research paper published on 20th May 2021. Adding to the list of environmental challenges facing agriculture, COVID-19 and the demographics of age, migration and urbanization pose a serious threat to the sustainability of farm businesses and food security[1]. In particular, farm businesses across the world are struggling to fill vacancies and provide safe working conditions for labourers. Autonomous robots could help address these immediate challenges[2]. Whilst their physical manifestation comprises hardware, such as a vehicle combined with manipulators, their autonomy is derived from sophisticated algorithms rooted in artificial intelligence. These algorithms fuse sensor data to enable control and real-time decision support. Autonomous robots can perform tasks collaboratively with humans (so-called co-bots) or on their own[2]. Apart from isolated on-farm examples, autonomous platforms with robotic mobility that fuse multiple technologies across a single fleet (for example, crop forecasting, planting, harvesting and packing) are not yet fully implementable and face substantial barriers. However, there is already adoption of static robotic milking technologies in the dairy sector and in-field deployment of tractor-mounted robotic manipulators to remove weeds and protect crops from pests and diseases[2].

O. A. Tanimola et.al [7]: This research paper published on August 2019. Over the last century, agriculture transformed from a labour-intensive industry towards mechanisation and power-intensive production systems, while over the last 15 years agricultural industry has started to digitise. Through this transformation there was a continuous labour outflow from agriculture, mainly from standardized tasks within production process. Robots and

artificial intelligence can now be used to conduct non-standardised tasks (e.g. fruit picking, selective weeding, crop sensing) previously reserved for human workers and at economically feasible costs. As a consequence, automation is no longer restricted to standardized tasks within agricultural production (e.g. ploughing, combine harvesting). In addition, many job roles in agriculture may be augmented but not replaced by robots. Robots in many instances will work collaboratively with humans. This new robotic ecosystem creates complex ethical, legislative and social impacts. A key question, we consider here, is what are the short and mid-term effects of robotised agriculture on sector jobs and employment? The presented work outlines the conditions, constraints, and inherent relationships between labour input and technology input in bio-production, as well as, provides the procedural framework and research design to be followed in order to evaluate the effect of adoption automation and robotics in agriculture.

H. A. B. Y. M. Gaikwd et.al [8]: In this review, we examine opportunities and challenges for 21st-century robotic agricultural cotton harvesting research and commercial development. The paper reviews opportunities present in the agricultural robotics industry, and a detailed analysis is conducted for the cotton harvesting robot industry. The review is divided into four sections: (1) general agricultural robotic operations, where we check the current robotic technologies in agriculture; (2) opportunities and advances in related robotic harvesting fields, which is focused on investigating robotic harvesting technologies; (3) status and progress in cotton harvesting robot research, which concentrates on the current research and technology development in cotton harvesting robots; and (4) challenges in commercial deployment of agricultural robots, where challenges to commercializing and using these robots are reviewed. Conclusions are drawn about cotton harvesting robot research and the potential of multipurpose robotic operations in general. The development of multipurpose robots that can do multiple operations on different crops to increase the value of the robots is discussed. In each of the sections except the conclusion, the analysis is divided into four robotic system categories; mobility and steering, sensing and localization, path planning, and robotic manipulation.

Ashish kumar chaudhari et.al [9]: Crop and Pasture Science (formerly known as Australian Journal of Agricultural Research) is an international journal publishing outcomes of strategic research in crop and pasture sciences and the sustainability of

farming systems. The primary focus is broad-scale cereals, grain legumes, oilseeds and pastures. Articles are encouraged that advance understanding in plant-based agricultural systems through the use of well-defined and original aims designed to test a hypothesis, innovative and rigorous experimental design, and strong interpretation. The journal embraces experimental approaches from molecular level to whole systems, and the research must present novel findings and progress the science of agriculture. Crop and Pasture Science is read by agricultural scientists and plant biologists, industry, administrators, policy-makers, and others with an interest in the challenges and opportunities facing world agricultural production. To facilitate accessibility and clarity, research papers should address a clearly enunciated hypothesis, and the Abstract should define the novel outcomes.

Arkin E. M. Fekete et.al [10]: This review article analyses state-of-the-art and future perspectives for harvesting robots in high-value crops. The objectives were to characterize the crop environment relevant for robotic harvesting, to perform a literature review on the state-of-the-art of harvesting robots using quantitative measures, and to reflect on the crop environment and literature review to formulate challenges and directions for future research and development. Harvesting robots were reviewed regarding the crop harvested in a production environment, performance indicators, design process techniques used, hardware design decisions, and algorithm characteristics. On average, localization success was 85%, detachment success was 75%, harvest success was 66%, fruit damage was 5%, peduncle damage was 45%, and cycle time was 33 s. A kiwi harvesting robot achieved the shortest cycle time of 1 s. Moreover, the performance of harvesting robots did not improve in the past three decades, and none of these 50 robots was commercialized. Four future challenges with R&D directions were identified to realize a positive trend in performance and to successfully implement harvesting robots in practice: (1) simplifying the task, (2) enhancing the robot, (3) defining requirements and measuring performance, and (4) considering additional requirements for successful implementation. This review article may provide new directions for future automation projects in high-value crops.

Reid J. F. Zhang et.al [11]: This study reviewed research published after 1990 on the economics of agricultural mechatronic automation and robotics, and identified research gaps. A systematic search was conducted from the following databases: ScienceDirect,

Business Source Complete, Wiley, Emerald, CAB Abstract, Greenfile, Food Science Source and AgEcon Search. This identified 4817 documents. The screening of abstracts narrowed the range to a dataset of 119 full text documents. After eligibility assessment, 18 studies were subjected to a qualitative analysis, with ten focused on automation of specific horticultural operations and eight related to autonomous agricultural equipment. All of the studies found some scenarios in which automation and robotic technologies were profitable. Most studies employed partial budgeting considering only costs and revenues directly changed by the introduction of automation or robotics and assuming everything else constant. None examined cropping system changes, or regional and national impacts on markets, trade and labour demand. The review identified a need for in-depth research on the economic implications of the technology. Most of the studies reviewed estimated economic implications assuming that technology design parameters were achieved and/or based on data from prototypes. Data are needed on the benefits and problems with using automation and robotics on farm. All of the studies reviewed were in the context of agriculture in developed countries, but many of the world's most pressing agricultural problems are in the developing world. Economic and social research is needed to understand those developing country problems, and guide the engineers and scientists creating automation and robotic solutions.

Avital Bechar et.al [12]: This review investigates the research effort, developments and innovation in agricultural robots for field operations, and the associated concepts, principles, limitations and gaps. Robots are highly complex, consisting of different sub-systems that need to be integrated and correctly synchronized to perform tasks perfectly as a whole and successfully transfer the required information. Extensive research has been conducted on the application of robots and automation to a variety of field operations, and has been widely demonstrated. Agricultural robots for field operations must be able to operate in unstructured agricultural environments with the same quality of work achieved by current methods and means. To assimilate , technologies must be developed to overcome continuously changing conditions and variability in produce and environments. Intelligent systems are needed for successful task performance in such environments. The robotic system must be cost-effective, while being inherently safe and reliable—human safety, and preservation of the environment, the crop and the machinery are mandatory. Despite much progress in recent years, in most cases the technology is not yet

commercially available. Information-acquisition systems, including sensors, fusion algorithms and data analysis, need to be adjusted to the dynamic conditions of unstructured agricultural environments. Intensive research is needed on integrating human operators into the for increased system performance and reliability. System sizes should be reduced while improving the integration of all . For robots to perform in agricultural environments and execute agricultural tasks, research must focus on: fusing complementary sensors for adequate and sensing abilities, developing simple manipulators for each agricultural task, developing path planning, navigation and guidance algorithms suited to environments besides open fields and known a-priori, and integrating human operators in this complex and highly dynamic situation.

Morton Lillomo et.al [13]: Recent advances in robot and sensor technology makes it possible to survey a large number of plants in a non destructive and cost efficient way. The present research approach includes measurements with VIS/NIR multispectral camera mounted on UAV and robot and traditional manual ground measurements. The analysis presented here, aims (1) to evaluate the use of multispectral imaging from drone and robot as phenotyping tools, (2) to compare images from drone and robot to see how they can complement each other for an optimized analysis of the plants and (3) to study the reflectance response of various plant species exposed to two different regimes of fertilizers. The sensors on UAVs provide a unique perspective of the growth of the plants revealing the map of the variations within the field of study.

Mohammad Thariq Hameed Sultan et.al [14]: This says that The agriculture industry is one that is highly resource- and labour-intensive. As such, farmers are increasingly turning to technology and automation to address this issue. However, agricultural robots are far too complicated, slow, and costly to be made publicly available. As a result, the agriculture sector still lags behind in integrating modern technologies. This research paper details the development of a low-cost agricultural robot for spraying fertilizers and pesticides in agriculture fields as well as for general crop monitoring. The prototype system is a two-wheeled robot that consists of a mobile base, a spraying mechanism, a wireless controller for controlling the robot movement, and a camera for crop health and growth monitoring as well as detecting the presence of pests in the agriculture field. Tests conducted on the prototype system show that while the productivity of the robot in terms of crop coverage is slightly lower than a human worker, the labour cost savings afforded

by the agricultural robot prototype is much greater as it functions completely in an autonomous mode and only requires the operator to control the robot when placing it at the start of the crop path. Furthermore, the prototype system also provides greater resource savings and reduction in the contamination of underground water sources due to leeching process, thus achieving precision agriculture goals. Lastly, the excellent battery life of the prototype system ensures that there will be no increase in the operation times and reduction in the efficiency of the fertilizer and pesticide spraying process due to the recharging times when replacing human workers. Future recommendations include making the agricultural robot fully autonomous, using either a rail- or line-following system, to further reduce the labour requirements and costs.

Shiva Gorijin et.al [15]: Rapid advancements in science and technology have become a driving force behind robotics and automation technology developments in agriculture. Digital agriculture has opened ways of improving efficiency and reducing energy inputs by utilizing information technology to make agricultural activities more productive and consistent. Implementation of digital and automation systems, including robots, communication networks, computer-based sensors and actuators, and other advanced farm machinery, has the potential to transform agricultural activities while there is still room for improvement. The increasing rate of using fossil fuels as the power source in agricultural farms will neither be affordable nor sustainable due to climate change concerns and the adverse effects of volatile fossil fuel prices on production costs. Solar energy is the most abundant and reliable source of energy, and photovoltaic (PV) technology is the predominant electrical renewable technology for electricity production. PV technology has gradually become an energy-saving and cost-effective technique in the transformation from traditional to modern agriculture. In this chapter, the utilization of PV systems in agricultural automation and robotics is presented and case studies are discussed.

CHAPTER - 3

SYSTEM ARCHITECTURE

3.1 Introduction

The project objectives, methods, literature evaluation, and other details were all clarified in the preceding chapter. The block diagram, circuit diagram, Working principle, and final project instrument cost analysis will all be covered in this chapter.

3.2 Block Diagram

Here is the block diagram of the **Multipurpose Agriculture Robot** with all the essential components. All of the components are shown in below as a block in this diagram.Here we use Node MCU Micro-controller of our project. Other equipment's are attached with this micro-controller and work together for perform as our desire outcome.

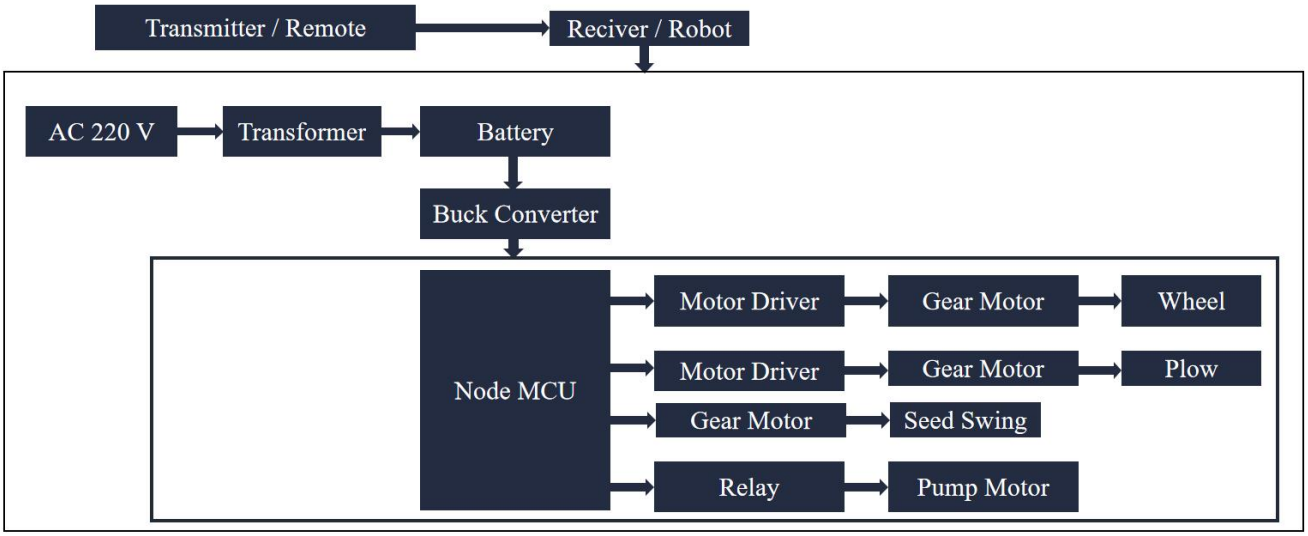


Figure 3.1: Block Diagram of Our System

3.3 Circuit Diagram

In this part we show our project circuit design and connect out instrument through standard wire.

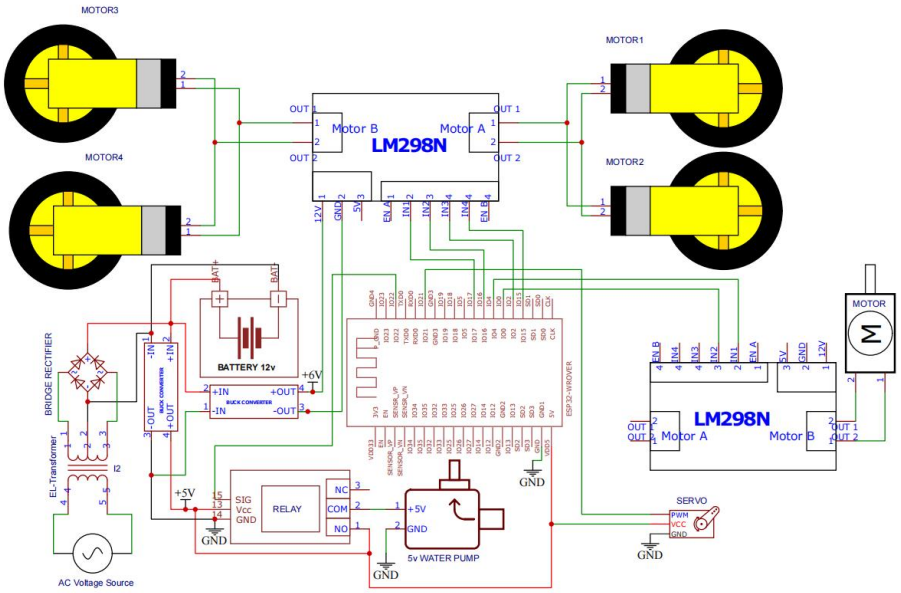


Figure 3.2: Schematic Diagram of Our System

3.4 Working Principle

The multipurpose agricultural robot operates using a DC power supply provided by a rechargeable battery, which can be charged through an AC to DC transformer. Buck converter is used to step down the voltage to safe levels for the on board components. The robot is controlled by a NodeMCU, which acts as the main control unit, managing all movements and farming operations. Four gear motors provide locomotion and are controlled via a motor driver to ensure smooth movement across the field. The plowing function is now operated using a servo motor, allowing precise control over soil tilling. Additional gear motors handle seed sowing, powered through a separate motor driver. Irrigation is carried out by a water pump motor, which is controlled via a relay. The robot is fully remote-controlled using NodeMCU-based transmitter/Android and receiver modules. Commands sent from the transmitter / Android are received and processed by the onboard NodeMCU, which executes the corresponding motion and farming tasks. This system allows efficient seed sowing, plowing, and watering, providing a cost-effective and practical automation solution for small-scale farming.

CHAPTER - 4

HARDWARE & SOFTWARE ANALYSIS

4.1 Introduction

In this section, we will discuss elaborately about " **Multipurpose Agriculture Robot**" and the component description, features, working procedure of our all equipment.The system hardware fabricates composed of power unit, source unit, power store unite, and many more related components.

4.2 Components List

Hardware Part

1. Node MCU
2. Battery
3. Buck Converter
4. Transformer
5. Gear Motor
6. Motor Driver
7. Pump Motor
8. Relay

Software Part

1. Arduino IDE
2. Easy EDA

4.3 Node MCU

Node MCU is an open source firmware for which open source prototyping board designs are available. The name "Node MCU" combines "node" and "MCU" (micro-controller unit). sand built on the Espressif Non-OS SDK for ESP32. It uses many open source projects, such as lua-cjson and SPIFFS. Due to resource constraints, users need to select the modules relevant for their project and build a firmware tailored to their needs. Support for the 32-bit ESP32 has also been implemented.



Figure 4.1: Node MCU

The prototyping hardware typically used is a circuit board functioning as a dual in-line package (DIP) which integrates a USB controller with a smaller surface-mounted board containing the MCU and antenna. The choice of the DIP format allows for easy prototyping on breadboards. The design was initially was based on the ESP-12 module of the ESP32, which is a Wi-Fi SoC integrated with a Tensilica Xtensa LX106 core, widely used in IoT applications. This an open source IoT platform. It includes firmware which runs on the ESP32 Wi-Fi SoC from Express if Systems, and hardware which is based on the ESP-12 module. The term "Node MCU" by default refers to the firmware rather than the development kits. The firmware uses the Luascripting language. It is based on the eLua project, and built on the Es press if Non-OS SDK for ESP32. Node MCU was created shortly after the ESP32 came out.

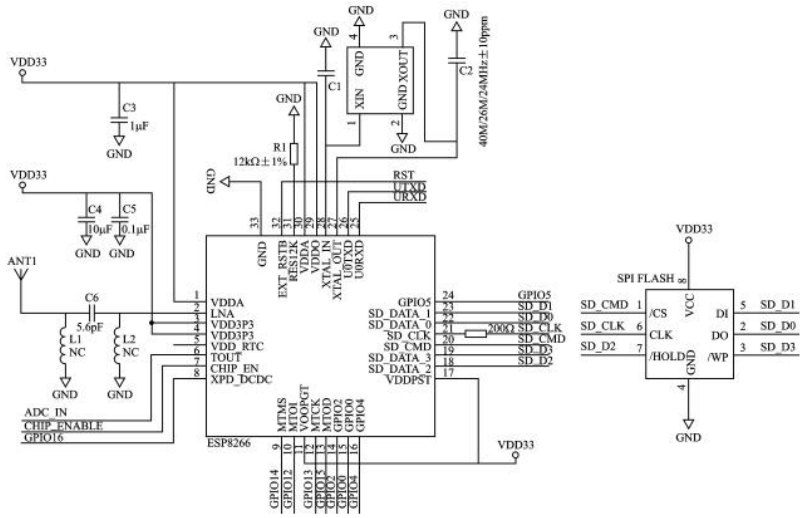


Figure 4.2: Node MCU Schematic Diagram [16]

Another important update was made on 30 Jan 2015, when Devsaurus ported the u8glibto Node MCU project, enabling Node MCU to easily drive LCD, Screen, OLED, even VGA displays. In summer 2015 the creators abandoned the firmware project and a group of independent contributors took over. By summer 2016 the Node MCU included more than 40 different modules. Due to resource constraints users need to select the modules relevant for their project and build a firmware tailored to their needs.

Node MCU V3 ESP32 ESP-12E is Wi-Fi development board that helps you to prototype your IoT product with few Lua script lines, or through Arduino IDE. The board is based on ESP32 ESP-12E variant, unlike other ESP-12E, you won't need to buy a separate breakout board, usb to serial adapter, or even solder it to a PCB to get started, you will only need a usb cable (Micro USB).

Features

- Communication interface voltage: 3.3V.
- Antenna type: Built-in PCB antenna is available.
- Wireless 802.11 b/g/n standard
- WiFi at 2.4GHz, support WPA / WPA2 security mode
- Support STA/AP/STA + AP three operating modes
- Built-in TCP/IP protocol stack to support multiple TCP Client connections (5 MAX)
- D0 ~ D8, SD1 ~ SD3: used as GPIO, PWM, IIC, etc., port driver capability 15mA
- AD0: 1 channel ADC
- Power input: 4.5V ~ 9V (10VMAX), USB-powered
- Current: continuous transmission: ≈70mA (200mA MAX), Standby: <200uA
- Transfer rate: 110-460800bps
- Support UART / GPIO data communication interface
- Remote firmware upgrade (OTA)

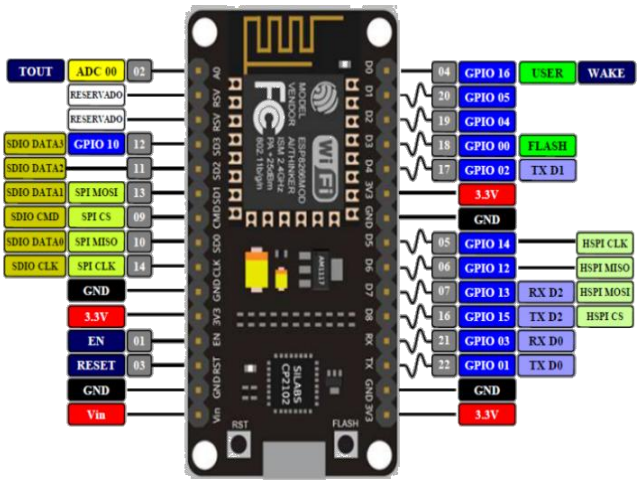


Figure 4.3: Node MCU Pin Out [17]

4.4 Battery

Lithium batteries are primary batteries that have metallic lithium as an anode. These types of batteries are also referred to as lithium-metal batteries. They stand apart from other batteries in their high charge density and high cost per unit. Depending on the design and chemical compounds used, lithium cells can produce voltages from 1.5 V (comparable to a zinc–carbon or alkaline battery) to about 3.7 V.

Disposable primary lithium batteries must be distinguished from secondary lithium-ion or a lithium-polymer, which are rechargeable batteries. Lithium is especially useful, because its ions can be arranged to move between the anode and the cathode, using an intercalated lithium compound as the cathode material but without using lithium metal as the anode material. Pure lithium will instantly react with water, or even moisture in the air; the lithium in lithium ion batteries is in a less reactive compound.



Figure 4.4: 3.7V Battery

Lithium batteries are widely used in portable consumer electronic devices. The term "lithium battery" refers to a family of different lithium-metal chemistry, comprising many types of cathodes and electrolytes but all with metallic lithium as the anode. The battery requires from 0.15 to 0.3 kg of lithium per kWh. As designed these primary systems use a charged cathode, that being an electro-active material with crystallographic vacancies that are filled gradually during discharge.

Product Specification

Voltage	3.7 V
Product Type	Lithium-Ion
Battery Capacity	2200mAh
Weight	45 g
Model Number	ICR 18650

Table 1: Battery Specification

4.5 Buck Converter

A buck converter (step-down converter) is a DC-to-DC power converter which steps down voltage (while drawing less average current) from its input (supply) to its output (load). It is a class of switched-mode power supply (SMPS) typically containing at least two semiconductors (a diode and a transistor, although modern buck converters frequently replace the diode with a second transistor used for synchronous rectification) and at least one energy storage element, a capacitor, inductor, or the two in combination. To reduce voltage ripple, filters made of capacitors (sometimes in combination with inductors) are normally added to such a converter's output (load-side filter) and input (supply-side filter). It is called a buck converter because the voltage across the inductor “bucks” or opposes the supply voltage.



Figure 4.5: DC -DC Buck Converter

DC-DC Buck Converter Step Down Module LM2596 Power Supply is a step-down(buck) switching regulator, capable of driving a 3-A load with excellent line and load regulation. These devices are available in fixed output voltages of 3.3 V, 5 V, 12 V, and an adjustable output version. The LM2596 series operates at a switching frequency of 150kHz, thus allowing smaller sized filter components than what would be required with lower frequency switching regulators.

Specifications of DC-DC Buck Converter Step Down Module LM2596 Power Supply

- Conversion efficiency: 92%(highest)
- Switching frequency: 150KHz
- Output ripple: 30mA9maximum)
- Load Regulation: ± 0.5%
- Voltage Regulation: ± 0.5%
- Dynamic Response speed: 5% 200uS
- Input voltage:4.75-35V
- Output voltage:1.25-26V(Adjustable)
- Switching Frequency: 150KHz
- Rectifier: Non-Synchronous Rectification
- Module Properties: Non-isolated step-down module (buck)
- Short Circuit Protection: Current limiting, since the recovery
- Operating Temperature: Industrial grade (-40 to +85) (output power 10W or less)

4.6 Transformer

A transformer is an electrical device used to change the value of an alternating voltage. Transformers are widely used in electrical work. They are encountered daily, in industrial, commercial and domestic situations. They vary in size from miniature units used in electronics to huge units used in power stations. The efficient transmission and distribution of electricity throughout the country would be impossible without the use of power transformers. Center Tapped Step Down Transformer is a general purpose chassis mounting mains transformer. Transformer has 230V primary winding and center tapped secondary winding. The transformer has flying colored insulated connecting leads (Approx 100 mm long). The Transformer act as step down transformer reducing AC - 230V to AC - 12V. The Transformer gives outputs of 12V, 12V and 0V.



Figure 4.6: Transformer

The Transformer's construction is written below with details of Solid Core and Winding. The transformer is a static electrical device that transfers energy by inductive coupling between its winding circuits. A varying current in the primary winding creates a varying magnetic flux in the transformer's core and thus a varying magnetic flux through the secondary winding. This varying magnetic flux induces a varying electromotive force (E.M.F) or voltage in the secondary winding. The transformer has cores made of high permeability silicon steel. The steel has a permeability many times that of free space and the core thus serves to greatly reduce the magnetizing current and confine the flux to a path which closely couples the winding.

Full Wave Bridge Rectifier

This type of single phase rectifier uses four individual rectifying diodes connected in a closed loop “bridge” configuration to produce the desired output.The main advantage of this bridge circuit is that it does not require a special centre tapped transformer, thereby reducing its size and cost. The single secondary winding is connected to one side of the diode bridge network and the load to the other side as shown below. The filtered full wave rectifier is created from the FWR by adding a capacitor across the output.

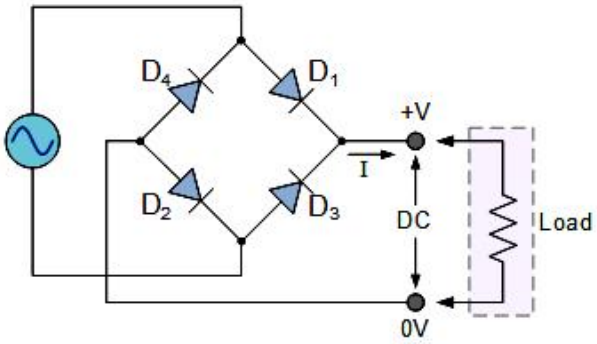


Figure 4.7: Full Wave Bridge Rectifier

The four diodes label led D1 to D4 are arranged in “series pairs” with only two diodes conducting current during each half cycle. During the positive half cycle of the supply, diodes D1 and D2 conduct in series while diodes D3 and D4 are reverse biased and the current flows through the load as shown below.

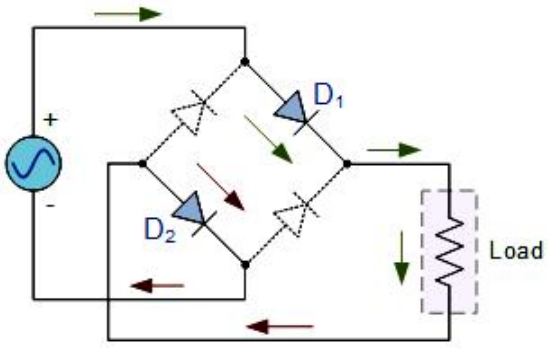


Figure 4.8: Positive Half Cycle of Full Wave Bridge Rectifier

The Positive half Cycle: During the negative half cycle of the supply, diodes D3 and D4 conduct in series, but diodes D1 and D2 switch “OFF” as they are now reverse biased. The current flowing through the load is the same direction as before.

4.7 Gear Motor

A DC motor is any motor within a class of electrical machines whereby direct current electrical power is converted into mechanical power. A 12v DC motor is small and inexpensive, yet powerful enough to be used for many applications.



Figure 4.9: DC Gear Motor

Specification

- Voltage: 12V DC
- Gear ratio: 1/31
- No-load speed: 200 RPM
- Rated Speed: 140 RPM
- Rated torque: 10 kg.cm
- Rated current: 2.5 Amp
- Length of Motor(including spindle): 106 mm/4.17″
- Diameter: 37 mm/1.45″
- Shaft length: 21 mm/0.82″
- Shaft diameter: 6 mm/0.24″

4.8 Relay

A relay is an electrically operated switch. Many relays use an electromagnet to mechanically operate a switch, but other operating principles are also used, such as solid-state relays. Relays are used where it is necessary to control a circuit by a separate low-power signal, or where several circuits must be controlled by one signal. The first relays were used in long distance telegraph circuits as amplifiers: they repeated the signal coming in from one circuit and re-transmitted it on another circuit. Relays were used extensively in telephone exchanges and early computers to perform logical operations.

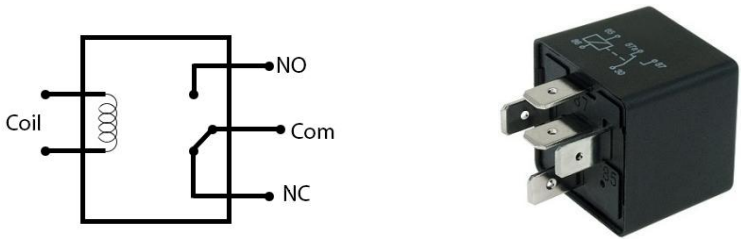


Figure 4.10: Relay

A type of relay that can handle the high power required to directly control an electric motor or other loads is called a contactor. Solid-state relays control power circuits with no moving parts, instead using a semiconductor device to perform switching. Relays with calibrated operating characteristics and sometimes multiple operating coils are used to protect electrical circuits from overload or faults; in modern electric power systems these functions are performed by digital instruments still called "protective relays".

Magnetic latching relays require one pulse of coil power to move their contacts in one direction, and another, redirected pulse to move them back. Repeated pulses from the same input have no effect. Magnetic latching relays are useful in applications where interrupted power should not be able to transition the contacts. Magnetic latching relays can have either single or dual coils. On a single coil device, the relay will operate in one direction when power is applied with one polarity, and will reset when the polarity is reversed. On a dual coil device, when polarized voltage is applied to the reset coil the contacts will transition. AC controlled magnetic latch relays have single coils that employ steering diodes to differentiate between operate and reset commands. The relay module is the one in the figure below.

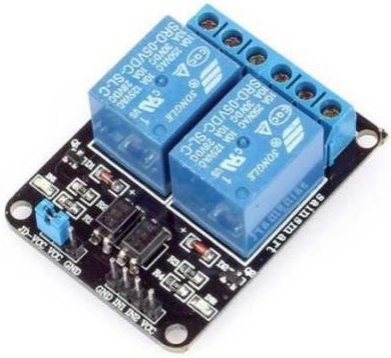


Figure 4.11: Relay Module

This module has two channels (those blue cubes). There are other varieties with one, four and eight channels.

Main's voltage connections.

In relation to mains voltage, relays have 3 possible connections:

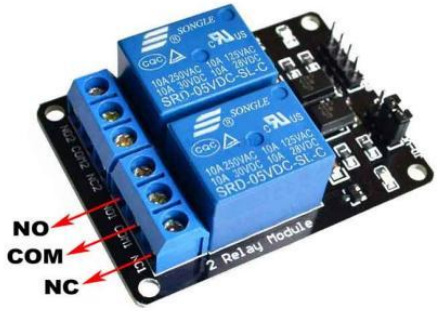


Figure 4.12: Main's voltage connections.

COM: common pin

NO (Normally Open): there is no contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and supply is provided to a load

NC (Normally Closed): there is contact between the common pin and the normally closed pin. There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to a load.



Figure 4.13: Voltage Connections

Pin wiring

The connections between the relay module and the Arduino are really simple:

GND: goes to ground

IN: controls the first relay (it will be connected to an Arduino digital pin)

IN2: controls the second relay (it should be connected to an Arduino digital pin if you are using this second relay. Otherwise, you don't need to connect it)

VCC: goes to 5V

4.9 Pump Motor

This is a low cost, small size Submersible Pump Motor which can be operated from a 12V DC power supply. It can take up to 120 litters per hour with very low current consumption of 220mA. Just connect tube pipe to the motor outlet, submerge it in water and power it. Make sure that the water level is always higher than the motor. Dry run may damage the motor due to heating and it will also produce noise.



Figure 4.14: Pump Motor

Feature

- Material: ABS(Acrylonitrile Butadiene Styrene) + Stainless Steel
- Overall Size: Approx. 80 x 48 x 63mm/3.15 x 1.89 x 2.48"
- Pump Inlet Diameter: 16mm(Outer), 12mm(Inner)
- Pump Outlet Diameter: 12mm(Outer), 6.9mm(Inner)
- Inlet/Outlet: 1/2" male thread
- Voltage: 6-12V DC
- Maximum Rated Current: 1.2A
- Power:16.8W
- Max Flow Rate: 700 L/H
- Max Water Head: 5M
- Max Circulating Water Temperature: 60°C

4.10 Motor Driver

The LM298N is a popular 16-Pin Motor Driver IC. As the name suggests it is mainly used to drive motors. A single LM298N IC is capable of running two DC motors at the same time; also the direction of these two motors can be controlled independently.

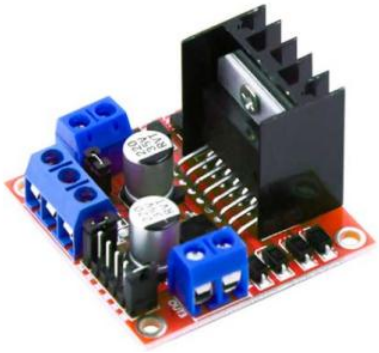


Figure 4.15: Motor driver IC LM298N

Working Process

LM298N IC is a typical Motor Driver IC which allows the DC motor to drive on any direction. This IC consists of 16-pins which are used to control a set of two DC motors instantaneously in any direction. It means, by using a LM298N IC we can control two DC motors.

LM298N Pin Configuration

Pin Number	Pin Name	Description
1	Enable 1,2	This pin enables the input pin Input 1(2) and Input 2(7)
2	Input 1	Directly controls the Output 1 pin. Controlled by digital circuits
3	Output 1	Connected to one end of Motor 1
4	Ground	Ground pins are connected to ground of circuit (0V)
5	Ground	Ground pins are connected to ground of circuit (0V)
6	Output 2	Connected to another end of Motor 1
7	Input 2	Directly controls the Output 2 pin. Controlled by digital circuits
8	Vcc2 (Vs)	Connected to Voltage pin for running motors (4.5V to 36V)
9	Enable 3,4	This pin enables the input pin Input 3(10) and Input 4(15)
10	Input 3	Directly controls the Output 3 pin. Controlled by digital circuits
11	Output 3	Connected to one end of Motor 2
12	Ground	Ground pins are connected to ground of circuit (0V)
13	Ground	Ground pins are connected to ground of circuit (0V)
14	Output 4	Connected to another end of Motor 2
15	Input 4	Directly controls the Output 4 pin. Controlled by digital circuits
16	Vcc2 (Vss)	Connected to +5V to enable IC function

Table 2: Pin Configuration of Motor Driver

Features

- Can be used to run Two DC motors with the same IC.
- Speed and Direction control is possible
- Motor voltage Vcc2 (Vs): 4.5V to 36V
- Maximum Peak motor current: 1.2A
- Maximum Continuous Motor Current: 600mA
- Supply Voltage to Vcc1(vss): 4.5V to 7V
- Transition time: 300ns (at 5Vand 24V)
- Automatic Thermal shutdown is available

Use of a L293D Motor Driver IC

Using this LM298N motor driver IC is very simple. The IC works on the principle of Half H-Bridge, let us not go too deep into what H-Bridge means, but for now just know that H bridge is a set up which is used to run motors both in clock wise and anti clockwise direction. As said earlier this IC is capable of running two motors at the any direction at the same time, the circuit to achieve the same is shown below.

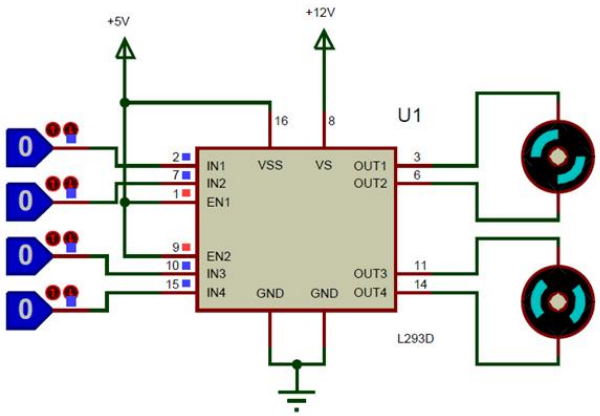


Figure 4.16: LM298N circuit Diagram

All the Ground pins should be grounded. There are two power pins for this IC, one is the Vss(Vcc1) which provides the voltage for the IC to work, this must be connected to +5V. The other is Vs(Vcc2) which provides voltage for the motors to run, based on the specification of your motor you can connect this pin to anywhere between 4.5V to 36V, here I have connected to +12V.

SOFTWARE

4.11 Arduino IDE

The digital microcontroller unit named as Arduino UNO can be programmed with the Arduino software IDE. There is no any requirement for installing other software rather than Arduino. Firstly, Select "Arduino UNO from the Tools, Board menu (according to the microcontroller on our board). The IC used named as ATmega328 on the Arduino UNO comes pre burned with a boot loader that allows us to upload new code to it without the use of an external hardware programmer.

Communication is using the original STK500 protocol (reference, C header files). We can also bypass the boot loader and programs the microcontroller through the ICSP (In Circuit Serial Programming) header. The ATmega16U2 (or 8U2 in the rev1 and rev2 boards) firmware source code is available. The ATmega16U2/8U2 is loaded with a DFU boot loader, which can be activated by:

On Rev1 boards: connecting the solder jumper on the back of the board (near the map of Italy) and then resetting the 8U2. On Rev2 or later boards: there is a resistor that pulling the 8U2/16U2 HWB line to ground, making it easier to put into DFU mode.The Arduino UNO is one of the latest digital microcontroller units and has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The ATmega328 provides UART TTL at (5V) with serial communication, which is available on digital pins 0 -(RX) for receive the data and pin no.1 (TX) for transmit the data. An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual com port to software on the computer. The '16U2 firmware uses the standard USB COM drivers, and no external driver is needed. However, on Windows, an .in file is required. The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the Arduino board.

The RX and TX LEDs on the board will flash when data is being transmitted via the USB-to-serial chip and USB connection to the computer (but not for serial Communication on pins 0 and 1). A Software Serial library allows for serial communication on any of the Uno digital pins. The ATmega328 also supports I2C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I2C bus. Arduino

programs are written in C or C++ and the program code written for Arduino is called sketch. The Arduino IDE uses the GNU tool chain and AVR Lab to compile programs, and for uploading the programs it uses argued. As the Arduino platform uses Atmel microcontrollers, Atmel's development environment, AVR Studio or the newer Atmel Studio, may also be used to develop software for the Arduino.

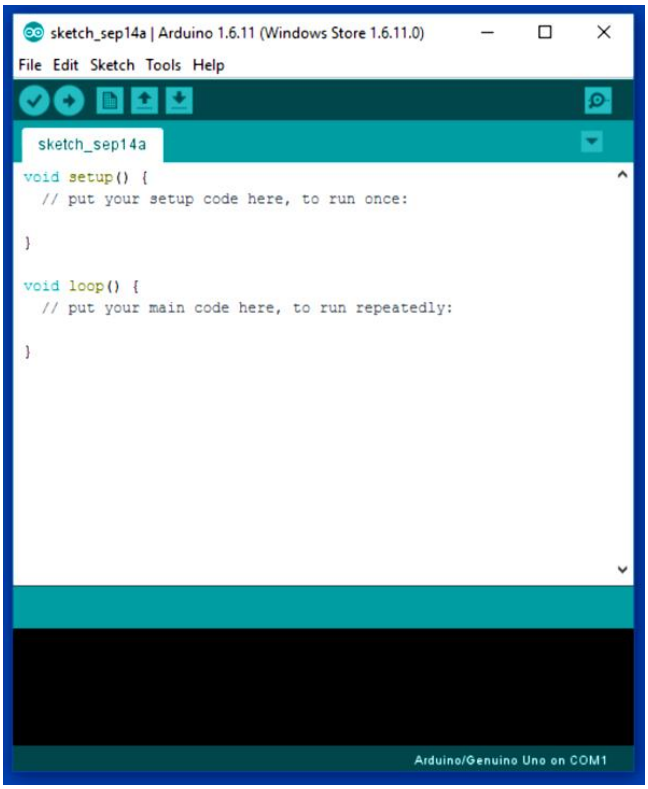


Figure 4.17: Arduino Software Interface IDE

The Arduino Integrated Development Environment - or Arduino Software (IDE) - contains a text editor for writing code, a message area, a text console, a toolbar with buttons for common functions and a series of menus. It connects to the Arduino and Genuino hardware to upload programs and communicate with them.

Writing Sketches

Programs written using Arduino Software (IDE) are called sketches. These sketches are written in the text editor and are saved with the file extension .ino. The editor has features for cutting/pasting and for searching/replacing text. The message area gives feedback while saving and exporting and also displays errors. The console displays text output by the Arduino Software (IDE), including complete error messages and other information.

The bottom righthand corner of the window displays the configured board and serial port. The toolbar buttons allow you to verify and upload programs, create, open, and save sketches, and open the serial monitor.

Sketchbook

The Arduino Software (IDE) uses the concept of a sketchbook: a standard place to store your programs (or sketches). The sketches in your sketchbook can be opened from the File > Sketchbook menu or from the Open button on the toolbar. The first time you run the Arduino software, it will automatically create a directory for your sketchbook. You can view or change the location of the sketchbook location from with the Preferences dialog. Beginning with version 1.0, files are saved with a .ino file extension. Previous versions use the .pde extension. You may still open .pde named files in version 1.0 and later, the software will automatically rename the extension to .ino.

Tabs, Multiple Files, and Compilation

Allows you to manage sketches with more than one file (each of which appears in its own tab). These can be normal Arduino code files (no visible extension), C files (.c extension), C++ files (.cpp), or header files (.h).

Uploading

Before uploading your sketch, you need to select the correct items from the Tools > Board and Tools > Port menus. The boards are described below. On the Mac, the serial port is probably something like /dev/tty.usbmodem241 (for an Uno or Mega2560 or Leonardo) or /dev/tty.usbserial-1B1 (for a Duemilanove or earlier USB board), or /dev/tty.USA19QW1b1P1.1 (for a serial board connected with a Keyspan USB-to-Serial adapter). On Windows, it's probably COM1 or COM2 (for a serial board) or COM4, COM5, COM7, or higher (for a USB board) - to find out, you look for USB serial device in the ports section of the Windows Device Manager. On Linux, it should be /dev/ttyACMx , /dev/ttyUSBx or similar. Once you've selected the correct serial port and board, press the upload button in the toolbar or select the Upload item from the Sketch menu. Current Arduino boards will reset automatically and begin the upload. With older boards (pre-Diecimila) that lack auto-reset, you'll need to press the reset button on the board just before starting the upload. On most boards, you'll see the RX and TX LEDs

blink as the sketch is uploaded. The Arduino Software (IDE) will display a message when the upload is complete, or show an error.

When you upload a sketch, you're using the Arduino boot loader, a small program that has been loaded on to the microcontroller on your board. It allows you to upload code without using any additional hardware. The boot loader is active for a few seconds when the board resets; then it starts whichever sketch was most recently uploaded to the microcontroller. The bootloader will blink the on-board (pin 13) LED when it starts (i.e. when the board resets).

Libraries

Libraries provide extra functionality for use in sketches, e.g. working with hardware or manipulating data. To use a library in a sketch, select it from the Sketch > Import Library menu. This will insert one or more #include statements at the top of the sketch and compile the library with your sketch. Because libraries are uploaded to the board with your sketch, they increase the amount of space it takes up. If a sketch no longer needs a library, simply delete its #include statements from the top of your code.

There is a list of libraries in the reference. Some libraries are included with the Arduino software. Others can be downloaded from a variety of sources or through the Library Manager. Starting with version 1.0.5 of the IDE, you do can import a library from a zip file and use it in an open sketch. See these instructions for installing a third-party library.

Third-Party Hardware

Support for third-party hardware can be added to the hardware directory of your sketchbook directory. Platforms installed there may include board definitions (which appear in the board menu), core libraries, bootloaders, and programmer definitions. To install, create the hardware directory, then unzip the third-party platform into its own sub-directory. (Don't use "arduino" as the sub-directory name or you'll override the built-in Arduino platform.) To uninstall, simply delete its directory.

For details on creating packages for third-party hardware, see the Arduino IDE 1.5 3rd party Hardware specification.

Serial Monitor

This displays serial sent from the Arduino or Genuino board over USB or serial connector. To send data to the board, enter text and click on the "send" button or press enter. Choose the baud rate from the drop-down menu that matches the rate passed to Serial.begin in your sketch. Note that on Windows, Mac or Linux the board will reset (it will rerun your sketch) when you connect with the serial monitor. Please note that the Serial Monitor does not process control characters; if your sketch needs a complete management of the serial communication with control characters, you can use an external terminal program and connect it to the COM port assigned to your Arduino board.

4.12 Easy EDA

Easy EDA is a web-based EDA tool suite that enables hardware engineers to design, simulate, share-publicly and privately-and discuss schematics, simulations and printed circuit boards. Other features include the creation of a bill of materials, Gerber files and pick and place files and documentary outputs in PDF, PNG and SVG formats. Easy EDA allows the creation and editing of schematic diagrams, SPICE simulation of mixed analogue and digital circuits and the creation and editing of printed circuit board layouts and, optionally, the manufacture of printed circuit boards.

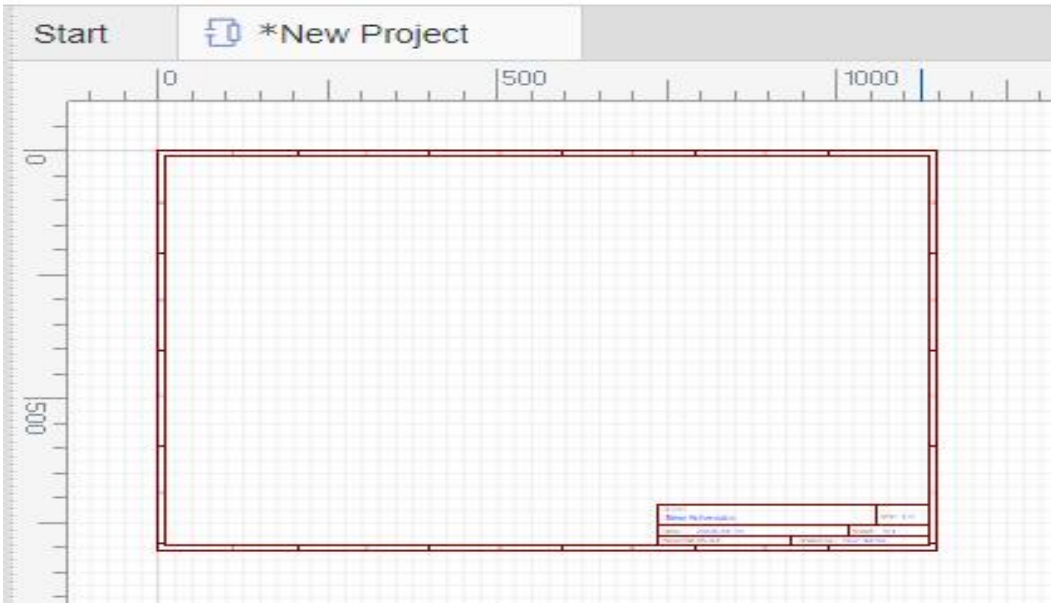


Figure 4.18: Easy EDA Software Interface

Subscription-free membership is offered for public plus a limited number of private projects. The number of private projects can be increased by contributing high quality public projects, schematic symbols, and PCB footprints and/or by paying a monthly subscription.Registered users can download Gerber files from the tool free of charge; but for a fee, Easy EDA offers a PCB fabrication service. This service is also able to accept Gerber file inputs from third party tools.

CHAPTER - 5

RESULT ANALYSIS

5.1 Project Outcome

After finally completing this project, we ran it & we observed the output of this project. We can see that it is working well as expected. After making our project we observe it very careful. It works as we desire. Our project give output perfectly and all equipment are work perfectly. We check how much it works and we get perfect output from this project.

- The robot successfully performs three key farming tasks: seed sowing, plowing, and watering.
- The NodeMCU-based transmitter and receiver provided stable and reliable wireless control within the expected range.
- Motor control for plowing offered precise soil tilling compared to traditional gear motor use.
- The gear motor-driven movement ensured smooth navigation on plain farmland surfaces.
- The water pump motor with relay switching delivered consistent irrigation output.
- The robot reduced manual labor effort, offering a cost-effective alternative for repetitive farming operations.
- Remote Control Functionality works effectively within the tested range, enabling smooth operation of movement and farming tasks.
- Wireless Communication remained stable with minimal lag during field tests.

5.2 Result Analysis

1.Testing Environment

Field Type: Small Agricultural Test Bed

Control Method: (Smartphone Controlled)

Mood: Automated.

2.Task Performed

Plowing

Sheed Sowing

Water Spraying

3.Plowing

Area Coverage: 5 Sq Meter

Time Taken: 05 Minute

4. Seed Sowing

Speed: 55 RPM

Row Length: 105 mm.

Seeds Name : Black Gram (Mash kalai)

Seeds Thickness (Average) : 2.29 mm

5.Water Spraying

Tank Capacity -2000 ml

Area Coverage-2 Sq Meter.

Time Taken: 35 Sec

6.Power Cosumption:

Battery :12 V DC

Full Charge Duration : 45 Minute Operation

Chargeing Time: 1.5 Hour.

This section presents a comparative analysis between the developed project and the multipurpose agricultural machine described in the research article titled “Design and Fabrication of Multipurpose Agricultural Machine” (JETIR, 2021). The focus of the comparison is on the operational design and performance of the seeding and water spraying mechanisms.

Seeding Mechanism

Features	**Design and Fabrication of Multipurpose Agricultural Robot**	**JETIR Project Description**
Operation type	Smart-phone operation	Manual operation
Seeding Driver	Motor driven shaft	Chain drive connected to front wheel
Seed Dropping Rate	1000 seed per minute based on 50 RPM	75 seeds per minute (based on 30 RPM, 5 openings)
Seed Delivery Control	Controlled via Smartphone System	Mechanical via drum seeder
Adjustability	Expected adjustable rate and distance control implemented	Fixed by mechanical design (regular interval via chain drive)

Water Spraying System

Features	**Design and Fabrication of Multipurpose Agricultural Robot**	**JETIR Project Description**
Operation Type	Pump system with smart phone operation	Gravity-based through PVC pipe with holes
Spray Mechnism	Pump system with hose pipe	Manual tap opening, no pressure pump
Flow Rate	70 ml/s	62.5 ml/s
Tank Capacity	2 Liter	20–30 liters (approx. 6–8 mins of spray time)
Automation Level	Higher / smart phone control Possible sensor integration	Basic (manual tap, constant flow)

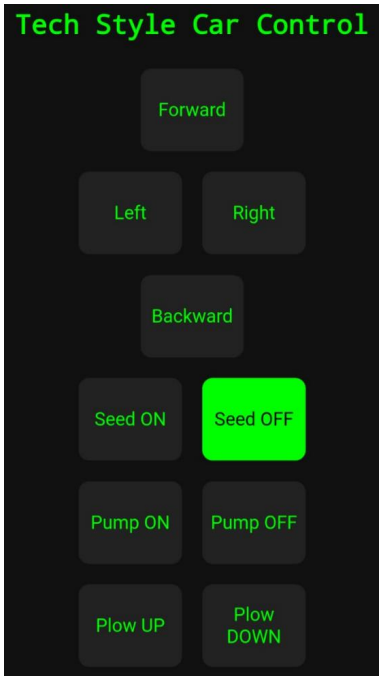


Figure 5.1 : Car Control

5.3 Complete Project Prototype

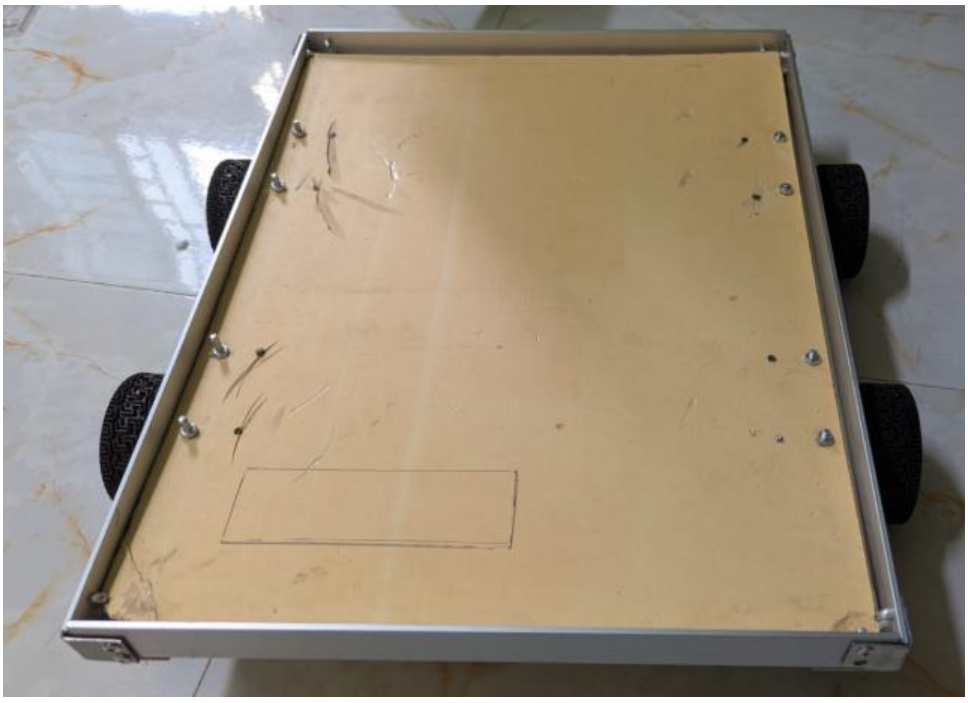


Figure 5.2: Agriculture Robot Base



Figure 5.3: Seed sowing Implement

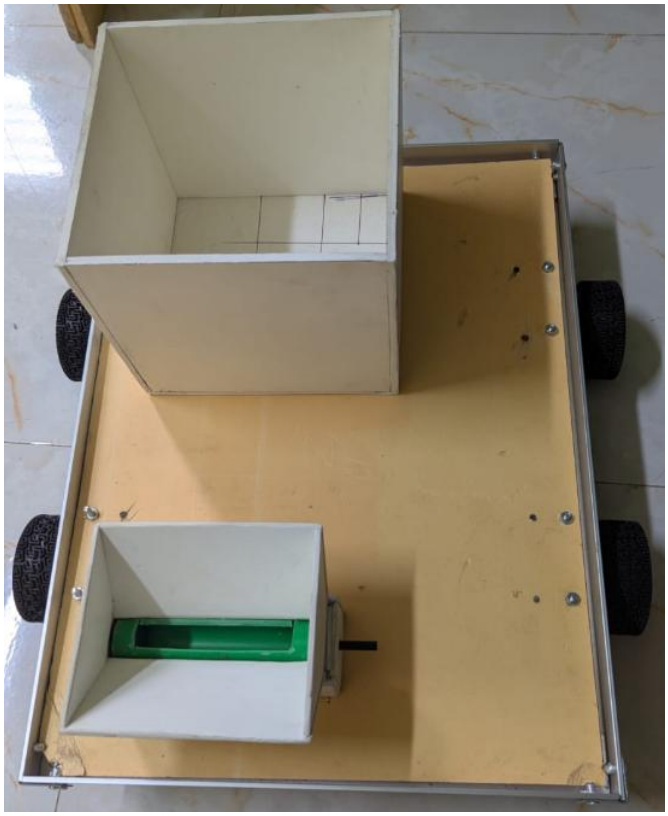


Figure 5.4: Hardware Progress Image

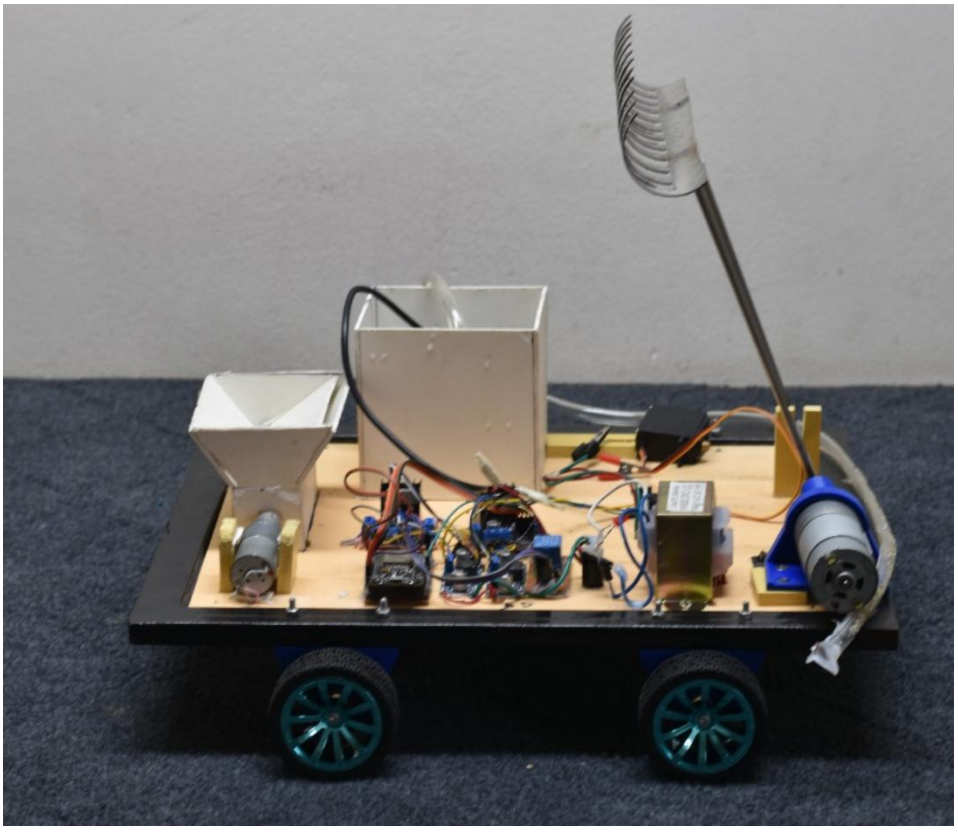


Figure 5.5: Our Final project

5.4 Advantage

There are many advantages of the project. Some of these are given below:

- The whole system is automatic system.
- Easy to use.
- Water Conservation
- Lowered Operation Costs
- Efficient and Saves Time
- User-friendly
- Automation
- Remote Control
- Multi-functionality
- User-Friendly
- Labor Reduction
- Eco-Friendly
- Precision Farming

5.5 Limitation

Through the project has many advantages it has also some limitation, they are given below:

- The system needs to be more efficient to produce more energy.
- Used cheap Chinese products for the prototype so there's some processing delay present in the circuit
- To get all notification mobile and project must be connected with the internet.
- This project can now be only used for small scale purposes.

5.6 Application

This project has applications in many fields due its necessity. We have selected a few of them and they are given below:

- In rural area
- For agriculture use
- In Indoor Garden
- In Flower Garden

5.7 Discussion

While working on our project, we did face some difficulties as it is a very complex system but the end results, we came up with were quite satisfactory. We have put the whole system through several tasks to validate our work and also have taken necessary notes for future improvements. Some future recommendations that we have involves improvement in system design and wiring, adding features for more efficient.

The multipurpose agricultural robot demonstrates how automation can simplify essential farming tasks such as seed sowing, plowing, and irrigation. By using NodeMCU as the control unit with a wireless transmitter and receiver, the system achieves reliable remote operation without the complexity of external communication modules. The integration of servo motor control for plowing provides better precision, while gear motors ensure smooth mobility and seed sowing. The water pump motor with relay switching offers efficient irrigation. Overall, the robot reduces human effort, saves time, and lowers costs, making it a practical solution for small-scale farmers seeking simple mechanization.

CHAPTER - 6

CONCLUSION

6.1 Conclusion

The multipurpose agricultural robot project successfully highlights the potential of simple automation in modern farming. Designed with NodeMCU as the central controller, the system integrates gear motors for mobility and seed sowing, a servo motor for plowing, and a water pump motor for irrigation. This configuration ensures reliable operation while reducing the need for complex sensors or costly technologies. The use of a NodeMCU-based transmitter and receiver allows smooth wireless control, enabling farmers to manage operations from a distance with ease. The prototype effectively demonstrates how seed sowing, plowing, and watering can be performed in an efficient, time-saving, and cost-effective manner. By reducing dependency on manual labor, the robot offers a practical solution to challenges faced in small-scale farming, such as rising labor costs and time management. Overall, this project contributes toward promoting agricultural mechanization, improving productivity, and showing how low-cost automation can play a vital role in sustainable farming practices.

6.2 Future Scope

As we have already discussed about the advantages, applications of our project so definitely there's room for improvement. Some of these are listed below:

- In future development this project can be develop by more sensor & alarm system (Soil Moisture Sensor)
- In Future we will add extra power system (Renewable Energy, Solar Panel).
- In future develop Control on IoT System
- In the future, add a GSM module to send an SMS alert system

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APPENDIX

Programming Code:

//**Transmitter** //

```
#include <WiFi.h>
#include <HTTPClient.h>

// Button pin configuration
const int btnUp =21 ;
//const int btnDown =4 ;
const int btnLeft = 18;
const int btnRight = 19;
const int ledPin = 2;       // WiFi status LED
#define btnDown 4          // Fan Relay

const int btnu =34 ;
const int btnd =32 ;
const int btnp =35;
const int btnr =39 ;

// Add these global variables at the top of your code
int pState = 0;          // Current toggle state (0 or 1)
int lastPButton = 0;     // Previous raw button read
bool pChanged = false;   // To detect new press

// Add these global variables at the top of your code
int rState = 0;          // Current toggle state (0 or 1)
int lastrButton = 0;     // Previous raw button read
bool rChanged = false;   // To detect new press

// WiFi target
String targetSSID = "ESP_SERVER";
String targetIP = "192.168.4.1";

// Function to connect to server
void connectToESPServer() {
  Serial.println("Scanning for ESP_SERVER...");
  int n = WiFi.scanNetworks();
  bool found = false;

  for (int i = 0; i < n; ++i) {
    if (WiFi.SSID(i) == targetSSID) {
      Serial.println("ESP_SERVER found. Connecting...");
```

```
      WiFi.begin(WiFi.SSID(i).c_str());

      unsigned long startTime = millis();
      while (WiFi.status() != WL_CONNECTED && millis() - startTime < 10000) {
        delay(500);
        Serial.print(".");
      }

      if (WiFi.status() == WL_CONNECTED) {
        Serial.println("\nConnected!");
        found = true;
      }
      break;
    }
  }

  if (!found) Serial.println("ESP_SERVER not found!");
}

void setup() {
  Serial.begin(115200);
  WiFi.mode(WIFI_STA);

  // Setup buttons
  pinMode(btnUp, INPUT_PULLUP);
  pinMode(btnDown, INPUT_PULLUP);
  pinMode(btnLeft, INPUT_PULLUP);
  pinMode(btnRight, INPUT_PULLUP);
  pinMode(ledPin, OUTPUT);
  pinMode(btnu, INPUT_PULLUP);
  pinMode(btnd, INPUT_PULLUP);
  pinMode(btnp, INPUT_PULLUP);
  pinMode(btnr, INPUT_PULLUP);
  connectToESPServer();
}

void loop() {
  // Read buttons (RAW values)
  int up = digitalRead(btnUp) == LOW ? 1 : 0;
  int down = digitalRead(btnDown) == LOW ? 1 : 0;
  int left = digitalRead(btnLeft) == LOW ? 1 : 0;
  int right = digitalRead(btnRight) == LOW ? 1 : 0;
  int u = digitalRead(btnu) == LOW ? 1 : 0;
  int d = digitalRead(btnd) == LOW ? 1 : 0;

  // ===== TOGGLE for p =====
  int pRaw = digitalRead(btnp) == LOW ? 1 : 0; // raw press detection
  if (pRaw == 1 && lastPButton == 0) {         // button just pressed
    pState = !pState;                          // toggle state
```

```
  pChanged = true;                        // mark change
 }
 lastPButton = pRaw; // store last read

 // Use pState instead of pRaw for sending
 int p = pState;


// ===== TOGGLE for r =====
 int rRaw = digitalRead(btnr) == LOW ? 1 : 0; // raw press detection
 if (rRaw == 1 && lastrButton == 0) {         // button just pressed
  rState = !rState;                       // toggle state
  rChanged = true;                          // mark change
 }
 lastrButton = rRaw; // store last read

 // Use pState instead of pRaw for sending
 int r = rState;
//  int r = digitalRead(btnr) == LOW ? 1 : 0;

 // Show on Serial
 Serial.printf("Up:%d Down:%d Left:%d Right:%d u:%d d:%d p:%d r:%d\n",
               up, down, left, right, u, d, p, r);

 if (WiFi.status() == WL_CONNECTED) {
  // Prepare JSON
  String payload = "{\"up\":" + String(up) + ",\"down\":" + String(down) +
                   ",\"left\":" + String(left) + ",\"right\":" + String(right) +
                   ",\"u\":" + String(u) + ",\"d\":" + String(d) +
                   ",\"p\":" + String(p) + ",\"r\":" + String(r) + "}";

  // HTTP POST
  HTTPClient http;
  http.begin("http://" + targetIP + "/data");
  http.addHeader("Content-Type", "application/json");
  int httpCode = http.POST(payload);

  if (httpCode > 0) {
   String response = http.getString();
   Serial.println("Response: " + response);
   digitalWrite(ledPin, HIGH);
  } else {
   Serial.println("POST failed");
   digitalWrite(ledPin, LOW);
  }
  http.end();
 } else {
  Serial.println("WiFi disconnected. Reconnecting...");
  digitalWrite(ledPin, LOW);
```

```
    connectToESPServer();
  }

  delay(10); // Shorter delay for better button response
}
```

//**Reciver** //

```
#include <WiFi.h>
#include <WebServer.h>
#include <ArduinoJson.h>
#include <ESP32Servo.h>  // Servo library

// ===== Motor Pins =====
const int IN1 = 12;
const int IN2 = 13;
const int IN3 = 14;
const int IN4 = 27;

// ===== Rotor Pins =====
const int r_IN3 = 25;
const int r_IN4 = 33;

// ===== Servo for Plow =====
Servo plowServo;
const int plowPin = 18;
int plowAngle = 60;  // initial position
const int plowMin = 0;
const int plowMax = 90;
const int plowStep = 5;

// ===== Pump Pin =====
const int pumpPin = 26;  // Choose any free GPIO pin for pump control

// ===== WiFi =====
const char* ssid = "ESP_SERVER";
WebServer server(80);

// ===== rotor Control Functions =====
void moverotorStop() {
  digitalWrite(r_IN3, LOW); digitalWrite(r_IN4, LOW);
}
void moverotorStart() {
  digitalWrite(r_IN3, HIGH); digitalWrite(r_IN4, LOW);
}

// ===== Motor Control Functions =====
void moveStop() {
```

```
  digitalWrite(IN1, LOW); digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW); digitalWrite(IN4, LOW);
}
void moveForward() {
  digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
  digitalWrite(IN3, HIGH); digitalWrite(IN4, LOW);
}
void moveBackward() {
  digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH);
  digitalWrite(IN3, LOW); digitalWrite(IN4, HIGH);
}
void moveLeft() {
  digitalWrite(IN1, LOW); digitalWrite(IN2, HIGH);
  digitalWrite(IN3, HIGH); digitalWrite(IN4, LOW);
}
void moveRight() {
  digitalWrite(IN1, HIGH); digitalWrite(IN2, LOW);
  digitalWrite(IN3, LOW); digitalWrite(IN4, HIGH);
}

// ===== Web Request Handler =====
void handleButtonControl() {
  if (!server.hasArg("plain")) {
    server.send(400, "text/plain", "Bad Request");
    return;
  }

  String body = server.arg("plain");
  StaticJsonDocument<200> doc;
  DeserializationError err = deserializeJson(doc, body);
  if (err) {
    server.send(400, "text/plain", "JSON Error");
    return;
  }

  int up = doc["up"];
  int down = doc["down"];
  int left = doc["left"];
  int right = doc["right"];
  int u = doc["u"];
  int d = doc["d"];
  int p = doc["p"];
  int r = doc["r"];

  Serial.printf("Up: %d | Down: %d | Left: %d | Right: %d | U: %d | D: %d | P: %d | R: %d
\n",
                up, down, left, right, u, d, p, r);

  // Motor control
```

```
  if (up == 0) moveForward();
  else if (down == 0) moveBackward();
  else if (left == 0) moveLeft();
  else if (right == 0) moveRight();
  else moveStop();

  // Pump control
  if (p == 0) digitalWrite(pumpPin, HIGH);
  else digitalWrite(pumpPin, LOW);

  // Rotor control
  if (r == 0) moverotorStart();
  else moverotorStop();

  // Servo control → increase / decrease angle
  if (u == 0) {
    plowAngle += plowStep;
    if (plowAngle > plowMax) plowAngle = plowMax;
    plowServo.write(plowAngle);
  }
  else if (d == 0) {
    plowAngle -= plowStep;
    if (plowAngle < plowMin) plowAngle = plowMin;
    plowServo.write(plowAngle);
  }

  server.send(200, "text/plain", "OK");
}

// ===== Setup =====
void setup() {
  Serial.begin(115200);
  WiFi.softAP(ssid);
  Serial.print("ESP32 AP IP: ");
  Serial.println(WiFi.softAPIP());

  // Motor pins
  pinMode(IN1, OUTPUT); pinMode(IN2, OUTPUT);
  pinMode(IN3, OUTPUT); pinMode(IN4, OUTPUT);
  moveStop();

  // Rotor pins
  pinMode(r_IN3, OUTPUT); pinMode(r_IN4, OUTPUT);
  moverotorStop();

  // Servo pin
  plowServo.attach(plowPin);
  plowServo.write(plowAngle);  // initial position
```

```
  // Pump pin
  pinMode(pumpPin, OUTPUT);
  digitalWrite(pumpPin, LOW);  // Default Pump OFF

  // Web server
  server.on("/data", HTTP_POST, handleButtonControl);
  server.begin();
}

// ===== Loop =====
void loop() {
  server.handleClient();
}
```